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# DISTRIBUTION, DEMOGRAPHY AND CONSERVATION STATUS OF THE INDIAN SARUS CRANE (*GRUS ANTIGONE ANTIGONE*) IN INDIA[1]

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(*With nine text-figures*)

**Key words:** Indian sarus crane, *Grus antigone antigone*, encounter rate, distribution, breeding population, recruitment, habitat use, conservation.

A district-level survey to determine the distribution, demography and status of the Indian sarus crane (*Grus antigone antigone*) was carried out between June 1998 and March 1999 in the states of Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal and Maharashtra. The survey discovered populations in Jammu & Kashmir and Himachal Pradesh, which are areas where sarus cranes have not been recorded since 1983. A total of 1,761 sarus were counted, and the districts with the highest encounter rates were Mainpuri and Etawah in Uttar Pradesh. The distribution range of the sarus crane in India has been drawn. The sarus crane population in India was seen to have an overall low percentage of breeding pairs in the population, and few juveniles, suggesting low recruitment. Factors significantly affecting the breeding are discussed. The cranes were seen to breed practically throughout the year, with two major peaks in February-March and July-August. Changes in land use patterns are presumed to affect habitat use by sarus cranes. The attitude of the local people towards the species is not conducive to the conservation of the vagile species. The implications of the above factors on the conservation of the species are discussed.

## INTRODUCTION

The sarus crane (*Grus antigone*) is the only crane species breeding south of the Himalayas and the only resident crane in India (Ali and Ripley 1980). Although previously widespread in south Asia, recent developmental activities within its range of distribution have reduced the range and the population of the species (Gole 1989, Meine and Archibald 1996). Three extant subspecies are recognised, and all three are known to be distinct in their habitat requirements and have different distribution ranges (Archibald and Meine 1996). The Indian sarus crane (*Grus a. antigone*) is the largest of the three subspecies and is currently found in Pakistan (C. Mirande *in litt.*) and India. It was found in Bangladesh as well, but may have become extinct (Meine and Archibald 1996). The sarus is held in religious regard in India, depicted in epics (Leslie 1998) and has cultural values attributed to it. The habit of pairing for life has given sarus cranes an iconic status in several places and they are zealously protected (Gole 1996). Research on the sarus crane has so far concentrated mostly on local status surveys (Parasharya *et al.* 1989, Singh and

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Khan 1989, Tatu 1999, Vyas 1999a). Information on imprinting, nidification and diet are available (Law 1930, Ali 1958, Ghorpade 1975) and work on certain aspects of breeding ecology and behaviour has been carried out in select localities (Ramachandran and Vijayan 1994, Vyas 1999b). A national survey to determine the distribution and status of the species was carried out in select states (Gole 1989). It is widely believed that sarus crane populations are declining all over India, and several people have expressed concern (e.g. S. Subramaniam *in litt.*).

We present information on the present distribution, aspects of demography, and conservation status of the Indian subspecies (henceforth referred to as sarus crane), based on two surveys carried out in 1998-99 in its historic distribution range. The survey was carried out exactly a decade after the first all-India survey by Gole (1989), and was aimed at identifying changes, if any, in distribution, population characteristics and status of the species in India.

Sarus cranes in India were known to be distributed in the states of Haryana, Gujarat, Rajasthan, Uttar Pradesh, Madhya Pradesh and a small population from Maharashtra (Archibald and Meine 1996). Anecdotal reports are available from Jammu & Kashmir and Himachal Pradesh, though their present status in these states is not reported (Gole 1996, Grimmett *et al.* 1998). In all the states, the sarus crane has suffered due to changing land use patterns that have degraded the natural landscape, particularly natural wetlands (Meine and Archibald 1996). This may be the main reason behind the apparent decline (Fig. 1) in their distribution range (Murray 1890, Ali and Ripley 1980, Johnsgard 1983, Gole 1989, Archibald and Meine 1996). The sarus crane is presently protected by the Indian Wildlife (Protection) Act 1972 under Schedule IV. It is considered internationally threatened and is proposed to be placed in the 'Endangered' category under criteria A1b,c,d,e by the IUCN. It is also in Appendix II of the CITES convention. The recent Conservation Action Plan by Meine and Archibald (1996) suggests that the species be moved to Category I of the IUCN and Appendix I of the CITES convention.

## STUDY AREA

The survey included the states of Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Rajasthan, Gujarat, Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal and Maharashtra. The second author surveyed Rajasthan, Punjab, Gujarat and Maharashtra; the first author surveyed the rest of the states, and both surveyed Himachal Pradesh. Surveys were carried out twice, since sarus crane distribution is known to change with cropping pattern (Archibald and Meine 1996). The first survey was carried out in summer (henceforth referred to as 'summer survey') during May to October 1998. The main crops grown during this season in the survey areas were paddy, sugarcane and soyabean. The second survey was carried out in winter (henceforth referred to as 'winter survey') from December 1998 to March 1999. The main crops grown during this season in the areas surveyed were wheat and mustard. The survey was spread over a year to obtain data on population status of the species and to determine breeding cycles in the sarus crane, since previous observations suggest that it has an asynchronous breeding that differs from place to place, depending on local conditions (Gole 1989, Ramachandran and Vijayan 1994). Jammu & Kashmir, Himachal Pradesh and West Bengal formed the outer fringe of the previously known sarus crane range of distribution (Gole 1996) and the species had not been reported here since Johnsgard (1983).

## MATERIAL AND METHODS

A rapid district level survey was carried out in the states mentioned above in two seasons. Jammu & Kashmir, Himachal Pradesh and West

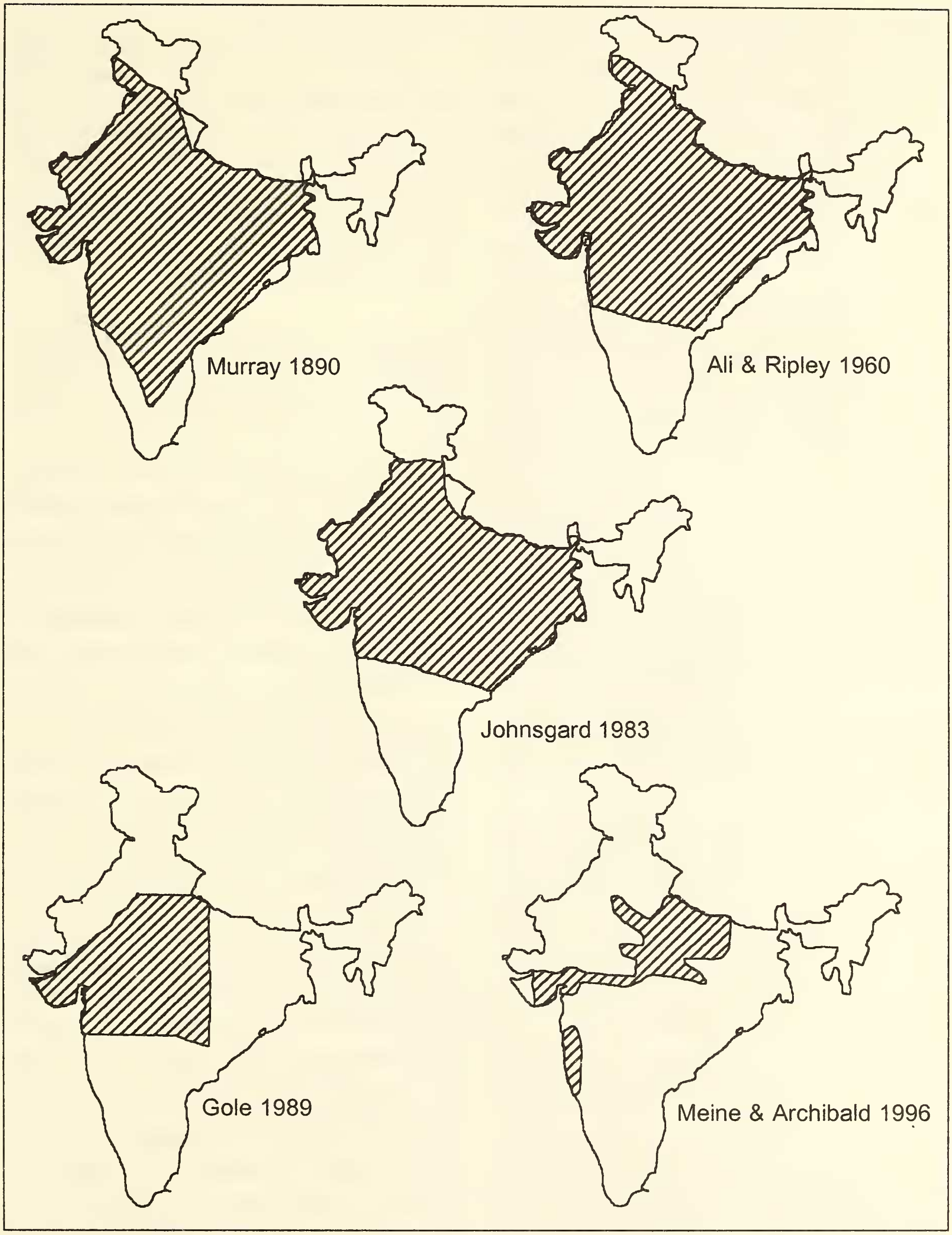


Fig. 1: Shrinking distribution range of sarus crane in India drawn from literature

Bengal were surveyed only in winter, and in two districts each, after secondary information suggested that these states might have a few individuals. Bihar could not be surveyed in winter due to unsteady political conditions. Districts that comprised the historic distribution range were visited to determine the presence, habitat use and status of the sarus.

Two methods were adopted to determine the abundance of sarus cranes in each district:

1. Transects (road or rail routes, referred to as 'road transect' and 'rail transect' respectively) were undertaken on an *ad hoc* basis to ascertain abundance and habitat use patterns by the sarus crane. This consisted of travelling by road on a pre-determined route and counting all the sarus cranes seen on either side of the road. In rail transects, both sides were monitored in some cases, but counts were usually made on one side only. Road transects were undertaken by a motor-bike, jeep or bus, counting sarus cranes seen on both sides of the road in all cases. Locations were recorded, using milestones. A Garmin 12 Global Positioning System was used in winter to record the locations of all sightings. Transects were selected to maximize possibility of sighting sarus cranes, based on published and local information.

2. Wetlands were visited, either while undertaking the transect or independently, chosen to maximize the chance of sarus crane sightings based on available literature and local information. 'Point counts' i.e. counts of all sarus cranes in a wetland and its immediate periphery, were done, using 7 x 50 binoculars from a vantage point. If the wetland was too big to be scanned from one place, the complete circumference was walked and all sarus cranes present were counted.

In addition, locals were shown colour plates of the species, and information on important nesting and roosting sites, foraging grounds, approximate number present in the vicinity, and attitude of the locals towards the species were collected.

If sarus cranes were not sighted, even after a transect was carried out, three wetlands visited and local people interviewed, and the secondary information did not confirm their presence, they were considered absent in the district. Data were analysed separately for the whole range of distribution and for each state. Encounter rates were calculated for all transects undertaken, using the simple relationship:

$$\text{Encounter rate} = \frac{\text{Number of sarus cranes counted on the transect (abundance)}}{\text{Total length of the transect (in km)}}$$

The winter transects and point counts in some districts were the same areas surveyed in the summer. Residential sarus cranes may have been recounted during the second survey.

Demographic parameters calculated were:

i. Percentage breeding population — defined as percentage of sarus crane pairs seen with eggs or young.

ii. Juvenile to adult ratio — chicks, juveniles and subadults (as defined by Ali and Ripley 1980) were clubbed together as 'juveniles' for the analysis, as they were in low numbers when counted separately. 'Recruitment' is defined as the number of juveniles counted.

Definitions of other terms used are indicated below:

'Pairs' were defined as two sarus cranes seen together, presumed to be one male and a female. These were differentiated from 'family', which consisted of a pair with young. 'Groups' were differentiated from 'congregations' based on the number of individuals seen together — 5 to 20 birds together were called 'groups' and any group having more than 20 birds was defined as a 'congregation'. Three or four adults seen together were designated as 'groups', except in cases when it was apparent that one (or two) of the cranes were being tended by the other two birds; then the former were regarded as offspring of the latter and the group was regarded as a 'family'.

Population estimates were not calculated from the survey results owing to three different methods used in conjunction, variation in time period of survey, and the biased methods of transects and wetland visits.

## Results and Discussion

**Abundance and encounter rates**: The survey covered a total of 11 states, 112 districts and 143 points (transects and wetlands). A total of 1,761 sarus individuals were counted, of which 772 were counted in the summer survey and 989 during the winter survey. Table 1 gives details of the districts surveyed, number of sarus cranes counted, calculated encounter rates, survey method(s), and the major crop(s) being grown in each district. Most of the sarus cranes were encountered in Uttar Pradesh and Rajasthan. In most places, more sarus cranes were encountered during the winter survey. Let us consider each state separately for the discussion.

**Jammu & Kashmir**: Only two districts were visited, based on secondary information received. A pair of sarus cranes was counted in one district. Information collected indicated that there were three more pairs in the same district. They did not seem to occur elsewhere in the state. The pair encountered was seen to breed by the locals, but no young have been observed. The wetland is very close to the Indo-Pakistan border, and is constantly disturbed by firing from both sides. There are several instances of poaching in the area (A. Rahmani *in litt.*) and the birds are not spared on either side of the border. This species has not been reported from this region since Johnsgard (1983).

**Himachal Pradesh**: Here also, sarus cranes were seen in one of the two surveyed districts. They have been sighted earlier in the Pong Dam area since 1995 (Lopez and Mundkur 1997 and S. Pandey, *pers. comm.*), and the numbers have increased since. We recorded a juvenile among the seven birds sighted, and the locals confirmed their breeding within the district. In Kulu, we were informed of a pair of sarus cranes that used to reside in the district. One of the pair died of a collision with high-tension power lines and the other was shot by poachers. No sarus cranes have been seen in the district since.

**Punjab**: Except for a stray record from Hoshiarpur district, obtained as secondary information from locals, there was no sign of the species. Poaching, conversion of natural wetlands to sugarcane and other agricultural fields, and other factors seem to have displaced the species from the state.

**Haryana**: The state was known to have substantial numbers of the sarus crane (Gole 1989). For the past three years, the state has suffered various degrees of drought, resulting in the drying up of natural wetlands. The few sightings in the state were in protected areas (Bhindawas Wildlife Sanctuary and Sultanpur Bird Sanctuary) where the water level is maintained by a system of canals. Sultanpur Bird Sanctuary used to host populations of up to 80 sarus cranes, several of which used to breed in the sanctuary (R.D. Jakati, *pers. comm.*), which has lost its appeal as a suitable habitat owing to the drought. Information from locals suggested that 10-15 birds are present in Panipat district. A few pairs have been sighted from trains in Palwal district as well, subsequent to the survey period (A. Kumar *in litt.*).

**Rajasthan**: Most of the 21 districts surveyed had sarus cranes in varying numbers. Seven of them, namely Chittorgarh, Bundi, Kota, Banswara, Bhilwara, Bharatpur and Bara, contributed to 29.81% of the total count of the entire survey. Together, they contributed to 88.84% and 81.42% of sarus cranes counted in the state during summer and winter respectively. Jodhpur, where we failed to record the species,

TABLE 1
SARUS CRANES ABUNDANCE AS COUNTED DURING THE SURVEY AND CALCULATED ENCOUNTER RATES (IN PARENTHESES) IN DIFFERENT DISTRICTS WITH INFORMATION ON SURVEY METHOD(S) AND MAJOR CROP(S) SEEN GROWING, 1998-99.

| Sl. | States and Districts covered | Crops grown | | Survey method | | Abundance (Encounter rate) | |
|---|---|---|---|---|---|---|---|
| | | S | W | S | W | S | W |
| I | Jammu & Kashmir | | | | | | |
| 1. | Jammu | * | P | * | 1 | * | 0 |
| 2. | Khatuga✱ | * | P | * | 1 | * | 2 |
| II | Himachal Pradesh | | | | | | |
| 1. | Kangra✱ | * | Wh | * | 2 | * | 7(0.03) |
| 2. | Kulu | * | Wh | * | 2 | * | 0† |
| III | Punjab | | | | | | |
| 1. | Amritsar | P | * | 1 | * | 0 | * |
| 2. | Hoshiarpur | P | Wh | 1 | 2 | 0 | 0† |
| 3. | Patiala | P | * | 1 | * | 0 | * |
| 4. | Ropar | P | * | 2 | * | 0 | * |
| IV | Haryana | | | | | | |
| 1. | Faridabad | Su | * | 2 | * | 0 | * |
| 2. | Gurgaon✱ | Su | * | 1 | * | 2 | * |
| 3. | Hisar | (Dry) | Wh | 2 | 2 | 0† | 0 |
| 4. | Kurukshetra | Wh | Wh | 2 | 2 | 0 | 0 |
| 5. | Panipat✱ | * | Wh | * | 2 | * | 0† |
| 6. | Rohtak | P, Su | * | 1 | * | 3 | * |
| 7. | Yamunanagar | O | * | 1, 2 | * | 0 | * |
| V | Rajasthan | | | | | | |
| 1. | Ajmer✱ | P | Wh | 1 | 1 | 0 | 10 |
| 2. | Alwar✱ | P | Wh | 1 | 1 | 2 | 6 |
| 3. | Banaswara✱ | P | Wh | 1, 2 | 2 | 33(0.1) | 33(0.13) |
| 4. | Bara✱ | P | Wh | 1, 2 | 1, 2 | 19(0.19) | 28(0.15) |
| 5. | Barmer | * | Wh | * | 2 | * | 0 |
| 6. | Bharatpur✱ | P | Wh | 1, 2 | 1, 2 | 21(0.08) | 39(0.35) |
| 7. | Bhilwara✱ | P | Wh | 2 | 2 | 16(0.06) | 49(0.2) |
| 8. | Bundi✱ | P | Wh | 1, 2 | 1, 2 | 44(0.18) | 45(0.18) |
| 9. | Chittorgarh✱ | P | Wh | 1, 2 | 1, 2 | 54(0.2) | 79(0.32) |
| 10. | Dausa✱ | * | Wh | * | 1 | * | 6 |
| 11. | Dhoulpur✱ | P | | 1 | 1 | 6 | 9 |
| 12. | Dungarpur | P | * | 2 | * | 0† | * |
| 13. | Jaipur✱ | P | Wh | 1 | 1 | 0 | 4 |
| 14. | Jalor | * | Wh | * | 2 | * | 2(0.02) |
| 15. | Jhalawar✱ | P | Wh | 1, 2 | 1, 2 | 6(0.04) | 18(0.09) |
| 16. | Jodhpur | * | M | * | 1, 2 | * | 0† |
| 17. | Kota✱ | P | Wh | 1, 2 | 1, 2 | 37(0.14) | 29(0.15) |
| 18. | Pali | P | Wh | 2 | 1 | 2(0.02) | 4 |
| 19. | Sawai Madhopur | P | Wh | 1 | 1 | 2(0.04) | 2 |
| 20. | Tonk✱ | P | Wh | 1, 2 | 1, 2 | 8(0.08) | 7(0.04) |
| 21. | Udaipur | P | * | 1 | * | 2 | * |
| VI | Gujarat | | | | | | |
| 1. | Ahmedabad✱ | P | Wh | 1, 2 | 1, 2 | 52(0.26) | 21(0.1) |
| 2. | Amreli✱ | * | Wh | * | 1 | * | 3 |

TABLE 1 (*contd.*)

SARUS CRANES ABUNDANCE AS COUNTED DURING THE SURVEY AND CALCULATED ENCOUNTER RATES (IN PARENTHESES) IN DIFFERENT DISTRICTS WITH INFORMATION ON SURVEY METHOD(S) AND MAJOR CROP(S) SEEN GROWING, 1998-99.

| Sl. | States and Districts covered | Crops grown | | Survey method | | Abundance (Encounter rate) | |
|---|---|---|---|---|---|---|---|
| | | S | W | S | W | S | W |
| 3. | Banaskantha✱ | * | | Wh | 1, 2 | * | 4(0.03) |
| 4. | Bharuch | P | Wh | 3 | 1, 2 | 0† | 2(0.04) |
| 5. | Bhavnagar✱ | P | Wh | 1, 2 | 1, 2 | 2(0.01) | 8(0.08) |
| 6. | Jamnagar | * | | * | 1, 2 | * | 4(0.02) |
| 7. | Junagadh | * | | * | 1 | * | 8 |
| 8. | Kheda✱ | P | Wh | 1, 2 | 1, 2, 3 | 40(0.2) | 58(0.34) |
| 9. | Kutch✱ | | | 1 | 1,2 | 4 | 10(0.05) |
| 10. | Mehsana✱ | P | Wh | 1 | 1 | 2 | 33 |
| 11. | Panchmahal | * | Wh | * | 1 | | 6 |
| 12. | Rajkot | P | * | 1, 2 | * | 0 | * |
| 13. | Saberkanta | * | Wh | * | 1, 2 | * | 4(0.04) |
| 14. | Surat | P | Wh | 3 | 2 | 0 | 0† |
| 15. | Surendranagar✱ | P | Wh | 1, 2, 3 | 1, 2 | 34(0.34) | 26(0.1) |
| 16. | Vadodara✱ | P | Wh | 1 | 1 | 4 | 4 |
| VII | Uttar Pradesh | | | | | | |
| 1. | Agra | (Dry) | * | 1, 2 | * | 0 | * |
| 2. | Aligarh✱ | P | Wh | 1, 2 | 1, 2 | 32(0.21) | 42(0.52) |
| 3. | Allahabad | P, Su | Wh, O | 2 | 1, 2 | 0† | 2(0.01) |
| 4. | Azamgarh | Su | * | 2 | * | 0 | * |
| 5. | Bahraich | * | Wh | * | 1,2 | * | 4(0.04) |
| 6. | Banda✱ | P | M | 2 | 2 | 14(0.09) | 8(0.06) |
| 7. | Ballia | Su | O | 2 | 1 | 0 | 0† |
| 8. | Bareilly✱ | Su, P | Su, Wh | 2 | 2 | 15(0.29) | 5(0.02) |
| 9. | Bijnor | Su | * | 2 | * | 0 | * |
| 10. | Deoria | Su | * | 2 | * | 0 | * |
| 11. | Etah✱ | P | Wh | 1, 2 | 1, 2 | 21(0.16) | 58(0.58) |
| 12. | Etawah✱ | P | Wh | 1, 2 | 1, 2 | 61(0.32) | 61(0.68) |
| 13. | Faizabad | Su | Wh | 1 | 2 | 7(0.06) | 1(0.01) |
| 14. | Farrukhabad | * | Wh | * | 2 | * | 7(0.08) |
| 15. | Fatehpur✱ | * | M | * | 2 | * | 5(0.07) |
| 16. | Gonda | P, Su | * | 3 | * | 7(0.05) | * |
| 17. | Gorakhpur✱ | Su | Su, M | 2 | 2 | 0 | 2(0.01) |
| 18. | Hamirpur | P | * | 3 | * | 2(0.01) | * |
| 19. | Jhansi | (Dry) | * | 2, 3 | * | 0 | * |
| 20. | Kanpur | * | M | * | 2 | * | 2(0.01) |
| 21. | Lakhimpur-Kheri | Su, P | M, Su | 1, 2 | 2 | 0 | 2(0.08) |
| 22. | Lalitpur | (Dry) | * | 2 | * | 0 | * |
| 23. | Maharajganj | P, Su | * | 2 | * | 4(0.07) | * |
| 24. | Mainpuri✱ | P | Wh | 1, 2 | 1, 2 | 79(1.5) | 158(1.3) |
| 25. | Mathura✱ | * | Wh | * | 3 | * | 22(0.21) |
| 26. | Mau | Su | * | 2 | * | 2(0.01) | * |
| 27. | Meerut | Su | * | 1, 2 | * | 0† | * |
| 28. | Mirzapur | * | (Dry) | * | 2 | * | 0 |
| 29. | Moradabad | Su | * | 2 | 2 | 0 | * |
| 30. | Pilibhit✱ | Su | Wh | 2 | 2 | 6(0.16) | 19(0.32) |
| 31. | Rae Bareli✱ | P | M | 2 | 1, 2 | 8(0.06) | 0† |

TABLE 1 (*contd*)

SARUS CRANES ABUNDANCE AS COUNTED DURING THE SURVEY AND CALCULATED ENCOUNTER RATES (IN PARENTHESES) IN DIFFERENT DISTRICTS WITH INFORMATION ON SURVEY METHOD(S) AND MAJOR CROP(S) SEEN GROWING, 1998-99.

| Sl. | States and Districts covered | Crops grown | | Survey method | | Abundance (Encounter rate) | |
|---|---|---|---|---|---|---|---|
| | | S | W | S | W | S | W |
| 32. | Shahjahanpur | P | M, Su | 2 | 2 | 10(0.08) | 15(0.08) |
| 33. | Siddharthnagar | P | * | 2 | * | 2(0.02) | * |
| 34. | Sirsa | * | M | * | 2 | * | 0 |
| 35. | Sitapur✱ | P | * | 2 | * | 18(0.15) | * |
| VIII | Madhya Pradesh | | | | | | |
| 1. | Bhopal✱ | So | Wh | 1, 2 | 1, 2 | 6(0.06) | 0 |
| 2. | Damoh | So | Wh | 2 | 2 | 0† | 2(0.02) |
| 3. | Dewas✱ | So | * | 2 | * | 0† | * |
| 4. | Dhar | So | * | 1, 2 | * | 0† | * |
| 5. | Guna | So | * | 2 | * | 2(0.03) | * |
| 6. | Gwalior | So | Wh | 2 | 2 | 0 | 2(0.03) |
| 7. | Hoshangabad | So | * | 1, 2 | * | 0 | * |
| 8. | Indore✱ | So | Wh | 1, 2 | 1 | 64 | 2(0.03) |
| 9. | Jabalpur | So | * | 1, 2 | * | 0 | * |
| 10. | Morena | * | O | * | 1 | * | 0† |
| 11. | Raipur✱ | * | Wh | * | 1, 2 | * | 2(0.02) |
| 12. | Raisen | P | Wh | 3 | 2 | 2(0.06) | 0 |
| 13. | Ratlam✱ | O | * | 1, 2 | * | 0† | * |
| 14. | Rewa | So | M, Su | 1, 2 | 2 | 0 | 0 |
| 15. | Sagar | So | Wh | 1, 2 | 2 | 0 | 2(0.01) |
| 16. | Sehore | So | * | 1 | * | 6(0.07) | * |
| 17. | Shajapur | So | * | 2 | * | 2(0.01) | * |
| 18. | Shivpuri | So | * | 2 | * | 1(0.01) | * |
| 19. | Ujjain | Su, So | * | 1 | * | 0 | * |
| IX | Maharashtra | | | | | | |
| 1. | Bhandara✱ | P | * | 1, 2 | * | 4 | * |
| 2. | Chandrapur✱ | P | * | 1 | * | 2 | * |
| X | Bihar | | | | | | |
| 1. | Patna | O | * | 2 | * | 0 | * |
| 2. | Motihari | P | * | 1 | * | 0 | * |
| 3. | Begusarai | P | * | 1 | * | 0 | * |
| XI | West Bengal | | | | | | |
| 1. | Cooch Bihar | * | O | * | 1, 2 | * | 0† |
| 2. | Jalpaiguri | * | Wh | * | 1, 2 | * | 0† |

S-Summer; W-Winter; Crops: P-Paddy, Wh-Wheat, Su-Sugarcane, So-Soyabean, M-Mustard, Wheat, O-Others

Survey method: 1-Wetland counts, 2-Road transect, 3-Train transect

✱ Districts where sarus cranes were seen breeding with eggs or with young, or places where secondary information indicated that they breed.

* Season when that district was not surveyed.

† Districts where sarus cranes were not encountered during the survey, but information from locals and other secondary information indicated that they are seen in certain areas in the district.

(Note: Encounter rates are calculated only for those districts where the transects were undertaken) is reputed to have a small non-breeding population during the monsoon. Most districts that were visited, during both seasons (with the exception of Kota and Tonk), had more sarus cranes recorded in winter. Encounter rate was the highest in Chittorgarh district during winter, which was probably due to a bias in the transect route selected. High encounter rates were recorded in Bundi and Kota districts, in comparison with other districts.

**Gujarat**: A total of 329 sarus cranes were counted. Just three districts, Kheda, Ahmedabad and Surendranagar, had 70.10% of the total count in the state. Of these, the latter two districts recorded a higher abundance in summer. Kutch had a very high encounter rate in winter. Surprisingly, Gole (1989) has not recorded this species from Kutch. Earlier records from the state suggest that populations of the species may have increased only recently, as they used to be "uncommon" previously (Ali 1954: 410). Kheda and Surendranagar districts recorded high encounter rates as well.

**Uttar Pradesh**: This state had the largest population of sarus cranes among the states surveyed. 73.04% of the total count in Uttar Pradesh were sighted in just four of the 35 districts surveyed namely Mainpuri, Etawah, Etah and Aligarh. Some of the districts were dry when surveyed and had correspondingly low numbers of sarus cranes. Mainpuri and Etawah recorded very high encounter rates, and are the most sarus-populated districts in the country. Etawah recorded an encounter rate of more than one bird per kilometre. In addition to a large number of birds spread out in the fields and small wetlands, certain wetlands in the district are congregation grounds and during the survey, the first author recorded a single congregation of 165 sarus cranes feeding in a dry field with grain stored in it. Etah and Aligarh districts also have very high numbers of these birds, which can be seen even along highways, feeding in roadside ditches.

**Madhya Pradesh**: The numbers of sarus cranes are generally low, which could be due to the fact that soyabean is the major crop in the state. Most of the sarus cranes counted were in one large flock in the Yashwanth Sagar Reservoir in Indore district. Encounter rates were uniformly low throughout the state. Wetlands in Ujjain district have a few pairs of resident sarus cranes. But the pressure on these wetlands for watering agriculture fields, bathing cattle, and several other domestic activities, is very high. Morena district (National Chambal Sanctuary) in the northern part of the state is reputed to have populations of up to 50 sarus cranes in winter (A.S. Pawar and R. Saxena, *pers. comm.*)

**Other States**: Maharashtra has a very small pocket of breeding sarus cranes. None were seen in Bihar and West Bengal. In Bihar, an anecdotal report of a pair near the Valmiki Tiger Reserve was the only evidence of the species in the state. In West Bengal, small populations were found visiting remote wetlands in Koochbihar district in winter.

**Seasonal difference in abundance and encounter rates**: The apparent difference in encounter rates and abundance between summer and winter may be due to the difference in availability of water and food (in the form of crops). In summer, most wetlands dry up, leading to sarus crane congregations in the few available perennial wetlands (as recorded in Indore), while in winter, sarus cranes are more widely spread out in the abundant natural wetlands and wheat fields in which they forage. Thus, surveys may yield higher counts if perennial waterbodies are identified and visited in summer for spot-counts, and transects are best undertaken in winter to calculate encounter rates and densities. Counts in waterbodies are best carried out early in the morning, before the birds disperse to forage, and in the late evenings when most of them have come to roost. This has been tried out successfully in Aligarh district (A. Rahmani *pers. comm.*). Contrary to the hypothesis that sarus crane distribution range differs between the two seasons, this survey recorded a similar distribution range for the species in both the seasons. Except for the population straying to the eastern fringe of the range in winter, they were recorded everywhere else in both seasons.

A comparison of population estimates from this survey with the data in Gole's (1989) report is unfortunately not possible, due to the different methods used. In addition, encounter rates for this survey have been calculated only for districts actually visited, and are thus not comparable with previous estimates of densities and populations for districts not actually surveyed. From the present survey, estimation of density was not possible. We suggest that results of future studies be presented as raw data, i.e. actual number of birds seen and total number of kilometres covered in transects (or encounter rates) to be helpful for comparison. Such representation of data would prove very helpful to analyze population changes over the years.

**Distribution**: Fig. 2 shows the distribution range of the sarus crane as projected after the present survey. Two ranges have been drawn on the map:

1. The outermost points known to have sarus crane populations have been connected (straight line) and represent the range of the species as a 'minimum convex polygon'.
2. The dotted line represents the range of the sarus crane as known from information collected from various sources. The international border of India forms the continuation of the dotted line wherever it is incomplete.

The limits of distribution can be defined as follows:

1. Kathua district in Jammu & Kashmir (32° 29' N) forms the northernmost region where sarus cranes are recorded in the country. This is weakly continuous with the populations in Himachal Pradesh, such as in Kangra district.

2. Sarus cranes are well distributed in the *terai* of Uttar Pradesh and their northernmost record in the state was at Meerut (29° 15' N). Another population to the north covered the districts of Hisar, Gurgaon, Rohtak and Panipat in Haryana.

3. Sarus populations were seen in Kutch district of Gujarat (69° 34' N). This forms the westernmost distribution of sarus cranes in the country. The western border extends across Rajasthan, covering Jalor, Pali and Jodhpur districts.

4. Maharashtra is the southernmost state, and Chandrapur district (20° 12' N) the southernmost point of sarus crane distribution. This extends to the northeast into Raipur district of Madhya Pradesh.

5. The easternmost record in the country is by Choudhury (1998) in Assam (95° 35' E). His sightings are seemingly discontinuous with the rest of the distribution range, as no sarus cranes were sighted during this survey in Bihar. The easternmost record in Uttar Pradesh was in Mau (83° 20' E). (Note: Information received from several places in Bihar after the survey suggests that several districts have populations of sarus cranes. Thus, the population is continuous after all, as has been represented in Fig. 2. A complete compilation of reports received subsequent to the survey is being prepared separately.)

*Breeding areas*: The districts and survey points where sarus cranes were recorded breeding are marked in Table 1 and Fig. 2 respectively. The breeding range does not extend eastwards as much as the distribution range, and its easternmost limit was recorded at Allahabad. The birds were seen breeding throughout the rest of the distribution range in the country.

**Demography**: *Breeding population*: The percentage of breeding pairs differed between states and seasons. Most breeding pairs were seen in Rajasthan, Gujarat and Uttar Pradesh in that order (Table 2). For the whole population, 19.76% pairs were recorded breeding. Most of the breeding records were made during the winter

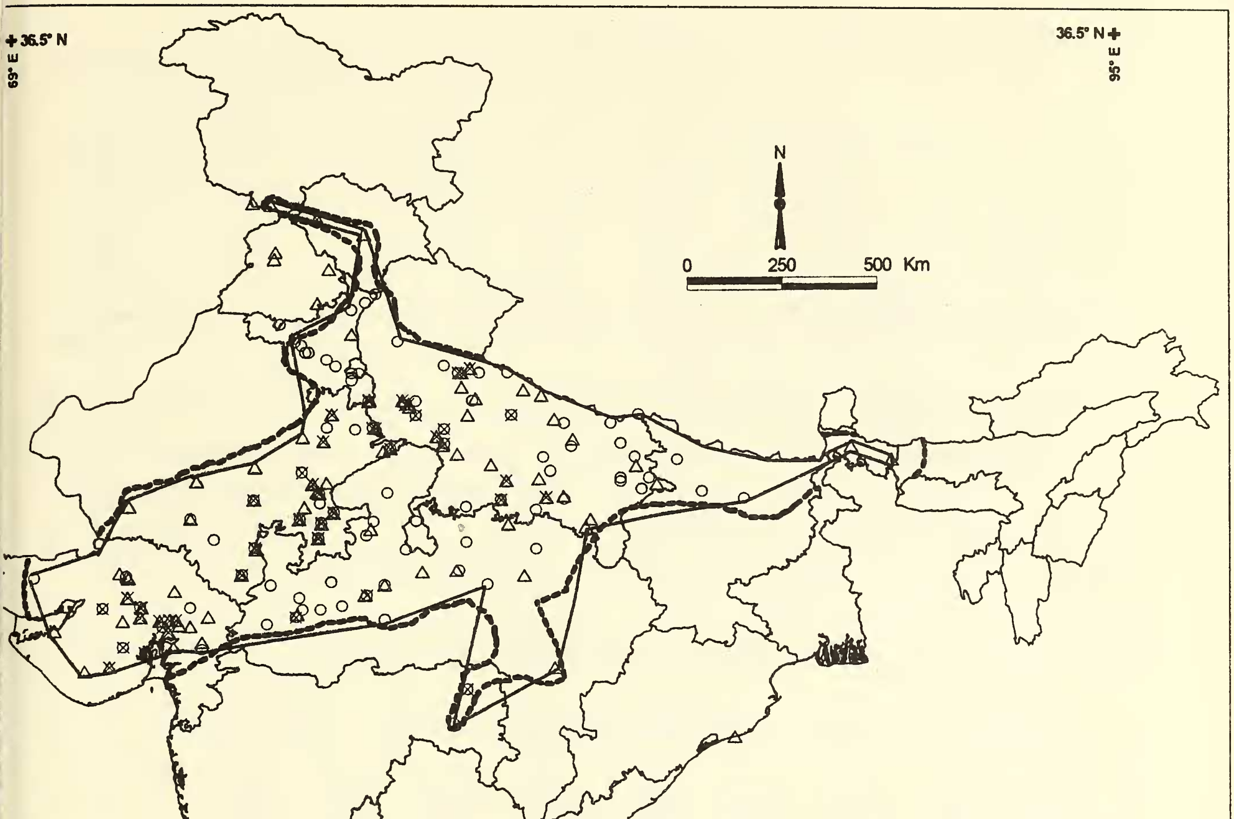

36.5° N
69° E
36.5° N
95° E
N
0 250 500 Km
69° E
10° N
10° N
95° E
○ Survey points (Summer 98)
△ Survey points (Winter 98 - 99)
× Nesting sites recorded during survey
Distribution range of sarus crane in India (Minimum convex polygon)
Projected distribution range of sarus crane in India

Fig. 2: Present distribution range of sarus crane as estimated from the survey with locations of survey points for the two seasons and observed breeding areas in India

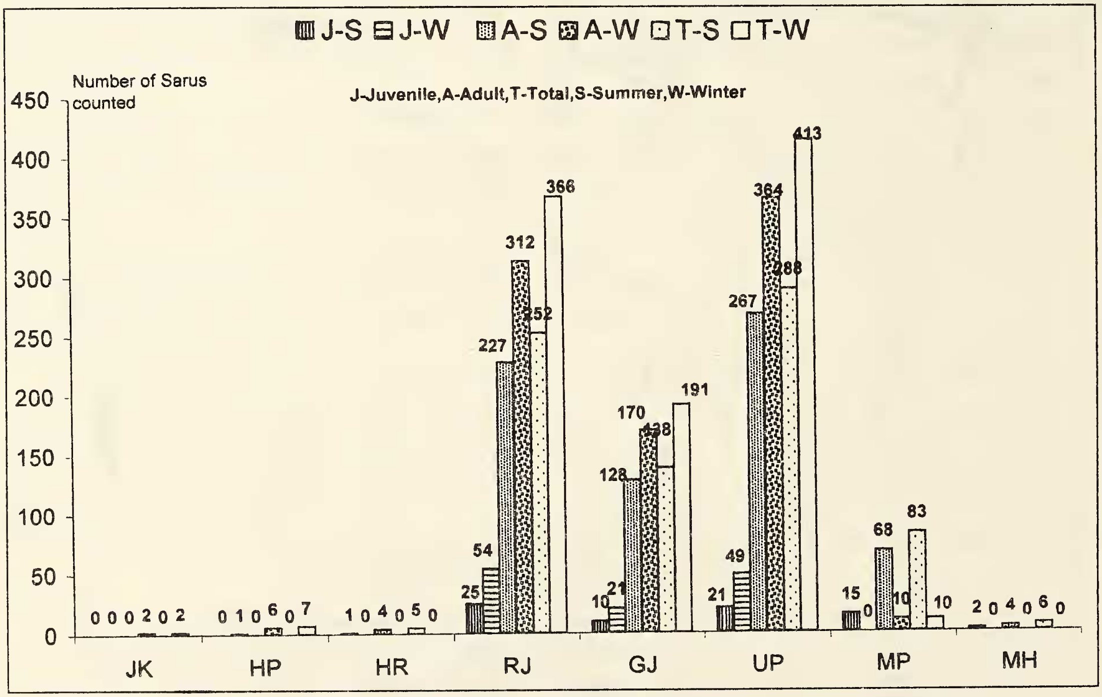
TABLE 2

DEMOGRAPHIC CHARACTERISTICS OF THE SARUS CRANE POPULATION IN DIFFERENT STATES SURVEYED

| State | % Breeding Pairs | | | Juveniles per 100 adults | | |
|---|---|---|---|---|---|---|
| | Summer | Winter | Total | Summer | Winter | Total |
| Rajasthan | 18.58 | 29.03 | 25 | 10 (252) | 15 (366) | 13 (618) |
| Gujarat | 12.5 | 22.35 | 18.12 | 7 (138) | 11 (191) | 9 (329) |
| Uttar Pradesh | 11.27 | 27.40 | 16.88 | 5 (288) | 12 (413) | 10 (701) |
| Madhya Pradesh | 10.53 | 0 | 9.76 | 5 (83) | 0 (10) | 4 (93) |
| Total | 14.49 | 24.17 | 19.76 | 7 (772) | 13 (989) | 10 (1761) |

(Figures in parentheses indicate the total number of cranes considered. Only states where 10 or more sarus were encountered are included in the analysis; other counts are included in calculating total values. Values have been rounded off for the juvenile-adult)

survey (December to March) as recorded previously (Gole 1989, Parasharya *et al.* 1989, Vyas 1999a, Vyas 1999b). Most breeding pairs had one offspring, but a few pairs in select districts had two chicks each. Of the breeding pairs recorded in Gujarat, Rajasthan and Uttar Pradesh, 14.81%, 16.67% and 23.08% respectively had two offsprings each, most of them in winter. This compares well with data on populations of other crane species which fledge two young, such as the whooping crane (*Grus americana*) – 14.5%, Eurasian or common crane (*G. grus*) – 24%, and whitenaped crane (*G. vipio*) – 27% (Johnsgard 1983).



JK - Jammu & Kashmir; HP - Himachal Pradesh; HR - Haryana; RJ - Rajasthan; GJ - Gujarat;
UP - Uttar Pradesh; MP - Madhya Pradesh; MH - Maharashtra.
(The same abbreviations hold good for the rest of the figures unless mentioned otherwise).

Fig. 3: State and season-wise sarus crane demography, 1998-99

*Juvenile to adult ratio*: The sarus crane population had 7 juveniles for every 100 adults in the summer and 10 in the winter (Fig. 3, Table 2). The ratio differed between states and seasons. Rajasthan had the highest recorded ratio of juveniles in winter with 15 juveniles counted for every 100 adults, followed by Uttar Pradesh, which had 12 in winter. The difference in recruitment between localities was because in some localities, pairs are able to rear two young, while in others, only one survives.

Data on recruitment in sandhill cranes (*Grus canadensis*) collected by Miller and Hatfield (1974) show much lower values than those calculated for the sarus crane; 3.5 in 1972 and 4.3 in 1973, for every 100 adult cranes in Saskatchewan, Canada. Ramachandran and Vijayan (1994) recorded a survival rate of 86% in fledglings in Keoladeo Ghana National Park. If this value is consistent among populations in different areas, the majority of the juveniles counted during the survey will survive to adulthood.

*Breeding cycle*: Most of the breeding was recorded in winter. However, the sarus crane seems to be breeding throughout the year (see Fig. 4 for month-wise breeding data). There were two major 'peaks' observed in the breeding pattern. The minor peak takes place in February-March, with the chicks hatching in March, or rarely, in early June. The second, i.e. the major breeding period starts almost immediately in July-August and continues till September-October, as is indicated by the large number of juveniles seen during this period, and the absence of single adults, implying completion of courtship and pair-bonding (Fig. 4). This observation is in accord with previous studies on local populations, where a minor breeding season (also referred to as sub-season) was observed in February-March

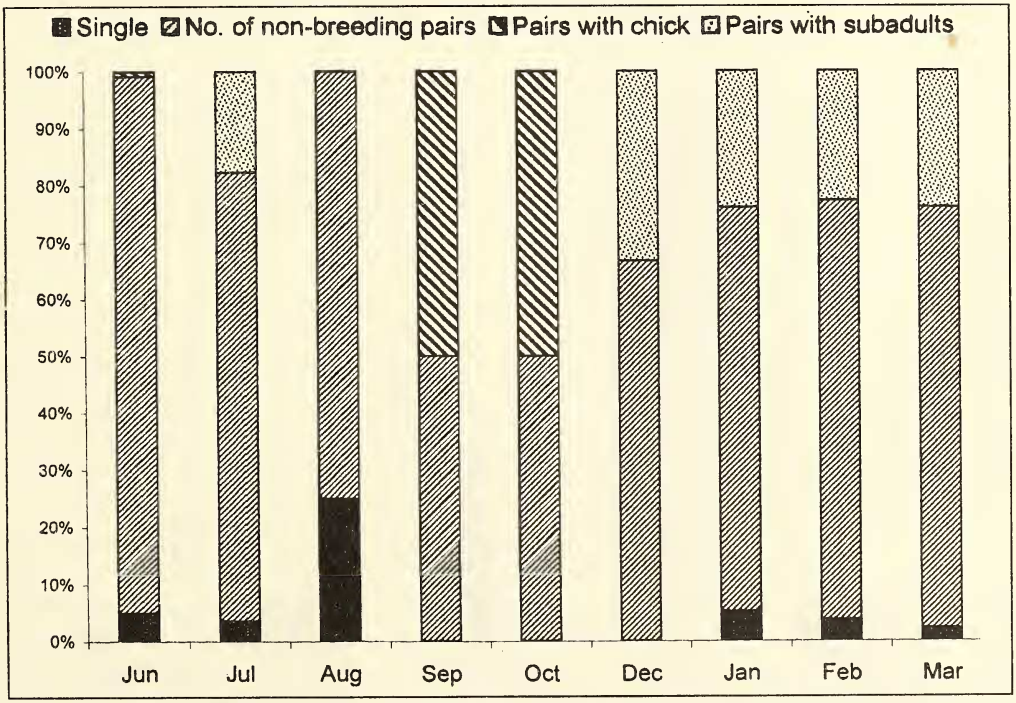


Fig. 4: Month-wise sarus crane demography, 1998-99

in Bharatpur (Ramachandran and Vijayan 1994) and in February-April in Kota (Vyas and Kulshreshta 1989). In these studies, the peak breeding season was observed in August-October and July-October, respectively. Such a bimodal pattern in the breeding leads to the following conjectures: (1) two groups are breeding in the same locality at different times, (2) pairs are breeding twice a year or (3) pairs with breeding failure in one season breed again in the next season in the same year. Long term studies on identified pairs would give insights into this aspect of sarus crane ecology.

*Group size*: Sarus cranes are characteristically seen in pairs at any time of the year (Fig. 5). Congregations and groups are rare, and a few families can be observed, though mostly in winter. This behaviour is markedly different from the common crane, demoiselle crane (*Anthropoides virgo*) and the blue crane (*A. paradiseus*), which are mostly seen in groups, often numbering tens of thousands, both in their wintering and breeding grounds (Johnsgard 1983, Allan 1995).

**Habitat use**: Data has been pooled for all age classes and group sizes since there was no marked difference in habitat utilization when assessed separately. In some cases, the data was insufficient to attempt separate analysis. Data on nest sites was not collected, as this was beyond the scope of the project, and warrants different methods. Sarus cranes were seen to use agriculture fields more than other habitat types (Fig. 6). There was a marked increase in the use of natural wetlands in winter, probably because of higher availability of the wetlands after monsoon. A few sarus cranes were seen in artificial wetlands such as bunded tanks, ponds and canals. Sarus cranes forage in shallow water with vegetation along the sides (Gole 1989) and are omnivores, feeding on fish (Law 1930), insects and tubers (Ghorpade 1975) and

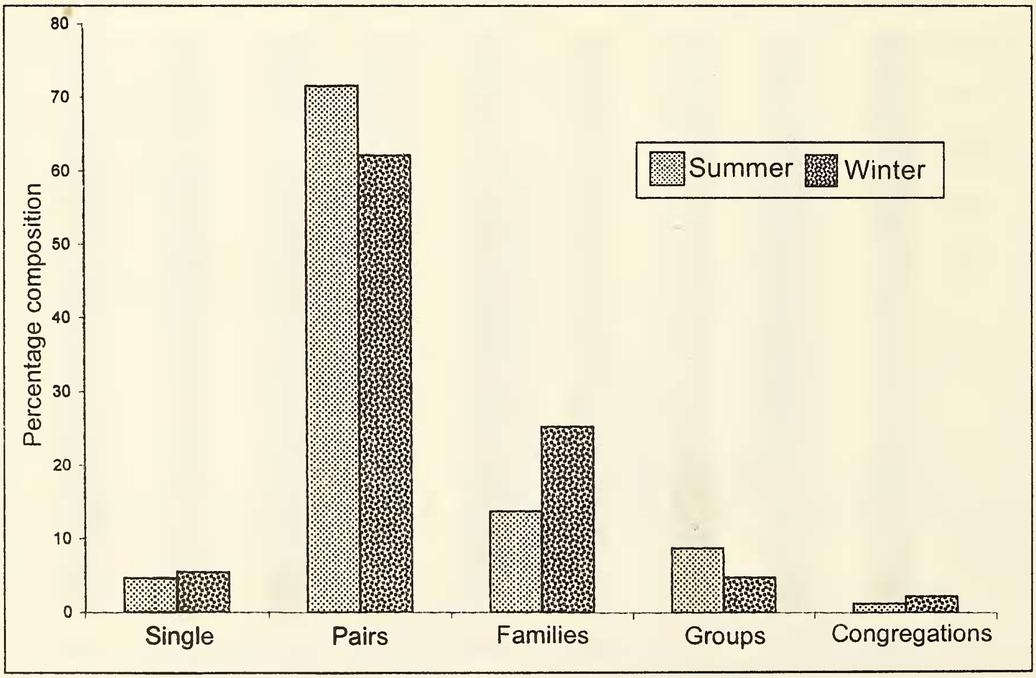


Fig. 5: Group size in sarus cranes

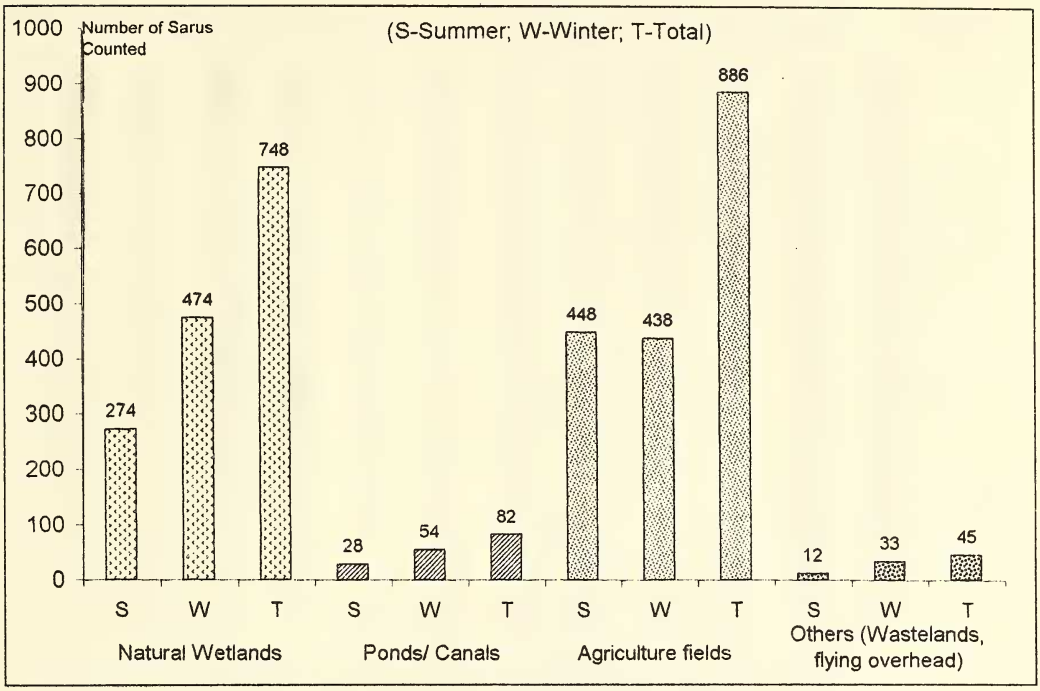


Fig. 6: Habitat use by sarus cranes in India

occasionally on eggs of other birds (Sundar, 2000). Artificial wetlands often have bare, steep sides and deep water at the edges. Natural wetlands, on the contrary, have vegetation on the banks, shallow at the sides and suitable for foraging by water birds, and therefore are preferable for sarus cranes.

Habitats were used differently in different states, presumably due to differential availability. In states with low sarus crane counts, information on differential habitat use is not available. In Jammu & Kashmir and Himachal Pradesh, they were seen in agriculture fields, while in Haryana and Maharashtra, they were seen in natural wetlands. In Uttar Pradesh, most of the sarus cranes were seen in agriculture fields in both seasons (Fig. 7). This could be due to a reduction in the number of natural wetlands and their conversion to agriculture fields (Gole 1989). The sarus cranes are perhaps faithful to the area where they lived. On the contrary, in both Rajasthan and Gujarat, they were found to prefer natural wetlands, and there was a marked increase in the use of natural wetlands in winter.

Among the crop fields, paddy and wheat were used most often in summer and winter respectively (Fig. 8). Sarus cranes eat large amounts of paddy and wheat prior to the harvest of these crops and can become pests (Parasharya *et al.* 1986). They find little to eat in other crop fields such as sugarcane and soyabean. When seen in areas with sugarcane and soyabean, most of the pairs were seen foraging in small puddles at the side of the fields and only one pair was observed preening themselves in the middle of a soyabean field.

All birds were seen in non-forested areas, except for one resident pair seen in a small wetland amid deciduous forested hills, in Dhar district, Madhya Pradesh. In Bandhavgarh Tiger Reserve, Madhya Pradesh, two pairs were reported to breed regularly in the grasslands

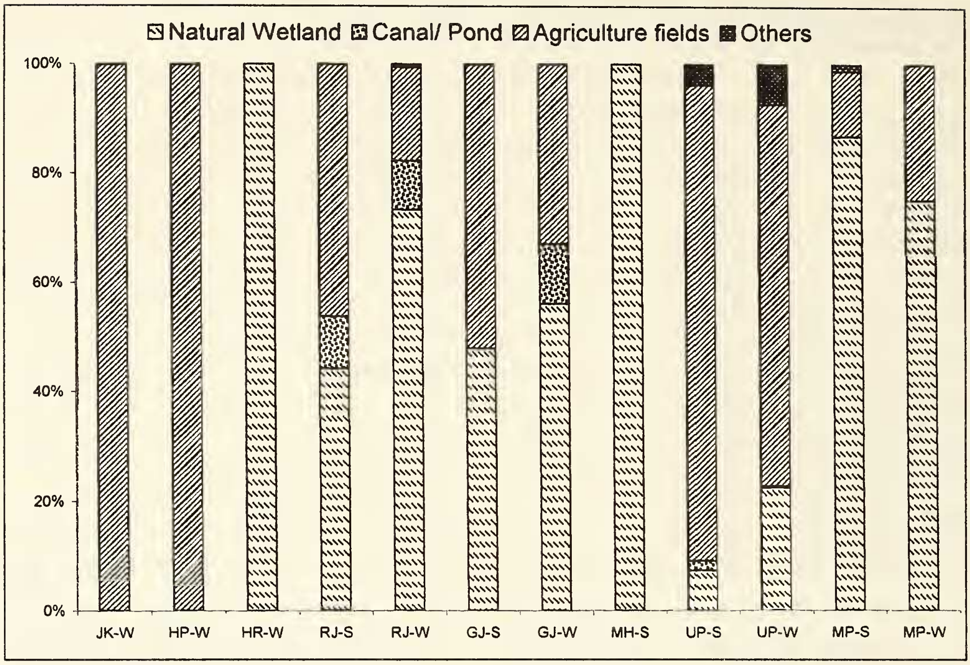
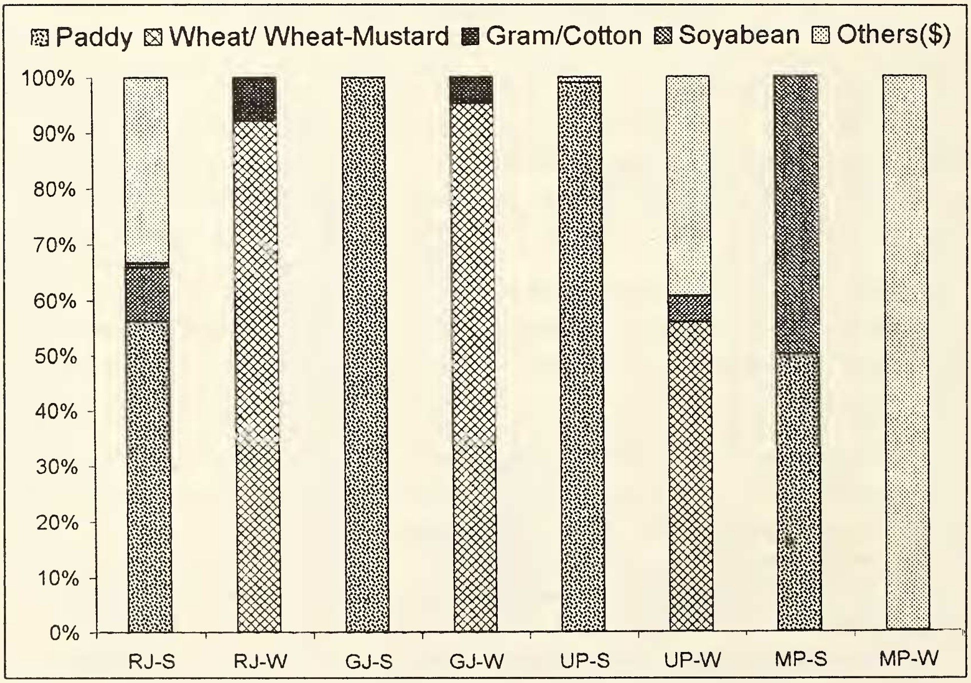


Fig. 7: State-wise habitat use by sarus cranes, 1998-99



$ - Includes inundated, groundnut and vegetable fields

Fig. 8: Crop-land used by sarus cranes in different states (In other states they used only natural wetlands)

amidst the forest. Interestingly, this area in Bandhavgarh was earlier under cultivation (A.K. Mishra, *pers. comm.*) and perhaps the pairs maintain site-fidelity. A similar observation was made in Kanha Tiger Reserve, Mandla district, Madhya Pradesh (Eric D'Cunha *in litt.*). A pair of sarus cranes were seen in the tanks of the Reserve's buffer zone until 1996, but are absent since. This area was previously agricultural as well. One of a pair was shot dead by villagers recently. This disturbance, and the removal of agricultural lands around the tanks would have served to displace the sarus from the area. No information on land use was available for the Dhar area. Non-breeding pairs were occasionally seen in wetlands in Dudhwa National Park, Uttar Pradesh (G. Maheshwaran, *in litt.*).

Three congregations were observed during the survey. Of these, two were recorded in paddy fields (one dry and one inundated), both in Etawah district, Uttar Pradesh. The other was in a reservoir in Indore district, Madhya Pradesh. Another congregation was reported from a natural wetland (riverside) from Banda district, Uttar Pradesh (S.A. Hussain, *pers. comm.*). Such congregations are supposed to be sites for unpaired birds to find partners (V. Prakash and A. Rahmani, *pers. comm.*). Otherwise, the cranes merely congregate to use the few wetlands during the dry months.

Pairs with young typically used open wetlands, natural or artificial (e.g. agriculture fields). The agriculture fields used were always interspersed with natural wetlands, small and/or large. In areas under sugarcane, pairs with young used the wetlands on the periphery of the fields.

Most crane species around the world select wetlands for breeding, and all species with the exception of the Siberian crane (*Grus leucogeranus*), use drylands as well for foraging (Johnsgard 1983). The blue crane and the demoiselle crane use dryland habitats throughout the year (Johnsgard 1983, Allan 1995). From past studies and the present survey, it is apparent that sarus cranes time their breeding to coincide with a period when food and water is in plenty. This strategy, combined with partial tolerance to changes in the landscape (such as continued use of habitats converted from natural wetlands to paddy fields, but seeming intolerance to sugarcane and soyabean fields), is good for the survival of the species. Other studies have documented the importance of paddy fields for water birds, and the effect of changes in agriculture practices — old practices with minimum disturbance continue to attract water birds (Lane and Fujioka 1998).

**Sarus cranes in protected areas:** Sarus cranes are vagile (free-flying) creatures, and are rarely contained completely within a protected area. Most of the population spends a great proportion of their time in unprotected, even private land. During the survey, we visited 13 protected areas, most of them bird sanctuaries, and discovered that the population present was negligible, except in certain cases where they seem to owe their survival in that district to the protected areas (Table 4). In Haryana, as mentioned before, the species was seen to be surviving almost completely in protected areas. In Gujarat, one district, namely Mehsana, had the majority of its sarus cranes in protected areas. In other districts, however, most of the individuals counted were in private land. In Uttar Pradesh, except for Rae Bareli, all districts had more sarus cranes in unprotected areas.

**Attitude of the local people towards sarus cranes**: Most of the sarus population is in private or otherwise unprotected areas, and there is a lot of interaction between the birds and the local people. The data collected by interviewing people in each state revealed that opinions differed from state to state (Fig. 9). In Uttar Pradesh and Maharashtra, there is a predominant feeling that the bird is a pest of crops: feeding on grain, and harming newly sown seedlings by clearing the ground for nesting. Most people in

TABLE 3
DEMOGRAPHIC CHARACTERISTICS OF SARUS CRANE POPULATIONS FROM VARIOUS STUDIES

| Source of information and area considered | % Breeding pairs | Juveniles per 100 adults |
|---|---|---|
| Parasharya *et al.* (1989) - in Gujarat | 42.87 | 21 |
| Vyas (1999a) - in Rajasthan and a few districts in MP | 27 | 19 |
| Gole (1989) - all India | 27.72 | 14 |
| Present study - all India | 19.76 | 10 |

(Values have been rounded off for the juvenile-adult ratio)

Madhya Pradesh were neutral to the species and understandably so, since it appears in such low numbers in the state. Also, in one season, the state is carpeted with soyabean, and it is only during the winter wheat harvest that sarus cranes can become pests. Uttar Pradesh, where the maximum number of people were interviewed, was the only state where all individuals knew of the sarus crane.

People who consider the bird as a pest are usually farmers affected by the birds feeding on the harvest in large quantities, and in whose fields the birds clear freshly sown seedlings to make nests. In the former case, they scare the birds away with loud noises or, in some cases, by throwing stones. Where nesting has begun, the farmers remove the eggs from the nests and may eat them, or place them in other sarus nests away from the fields (Parasharya 1998). We did not record any instance of the farmers shooting the birds to keep them away.

From literature (Gole 1989, 1996, Meine and Archibald 1996), it would seem that sarus cranes in India are protected by the locals due to the religious significance attributed to the birds. However, from our survey, 495 of the 1,339

TABLE 4
SARUS CRANE NUMBERS IN PROTECTED AREAS AND TOTAL
NUMBER SEEN IN THE DISTRICT (IF THEY WERE SIGHTED ELSEWHERE)

| State | | Protected area visited | Sarus cranes counted* | Sarus cranes counted in the district* |
|---|---|---|---|---|
| I. | Haryana | | | |
| 1. | Rohtak | Bhindawas Wildlife Sanctuary | 3 | 3 |
| 2. | Gurgaon | Sultanpur Bird Sanctuary | 2 | 2 |
| II. | Rajasthan | | | |
| 1. | Bharatpur | Keoladeo-Ghana National Park | 26 | 56 |
| III. | Gujarat | | | |
| 1. | Mehsana | Thol Lake Bird Sanctuary | 35 | 35 |
| 2. | Ahmedabad | Nalsarovar Bird Sanctuary | 17 | 73 |
| 3. | Surendranagar | Tundi Talab (in Wild Ass Sanctuary) | 10 | 54 |
| 4. | Bhavnagar | Velavadar National Park | 5 | 8 |
| IV. | Uttar Pradesh | | | |
| 1. | Meerut | Hastinapur Wildlife Sanctuary | 2† | 0 |
| 2. | Lakhimpur-Kheri | Dudhwa Wildlife Sanctuary | 0 | 2 |
| 3. | Agra | Keetham Jheel | 0 | 0 |
| 4. | Etah | Patna Bird Sanctuary | 20 | 79 |
| 5. | Mainpuri | Saman Bird Sanctuary | 16 | 237 |
| 6. | Rae Bareli | Samaspur Bird Sanctuary | 15-20† | 8 |

* - Total number of sarus cranes seen in both seasons. Territorial pairs may have been recounted during the second survey.
† - Information provided by local forest staff.

people questioned (37%) regarded the bird as a pest, whereas 501 individuals (37.4%) held the bird in religious esteem. There is not much difference between these percentages, and the sentiments of people could be changing — for the worse.

**Mortality in sarus cranes**: Breeding pairs were seen to be at risk of colliding with high-tension power lines. Pairs breeding in natural wetlands and agriculture fields fly in and out of the nesting sites and occasionally collide with the overhead wires. Observations in Mainpuri and Etawah suggest that, of the resident population, the cranes affected in this manner could be between 2.5% and 20% respectively (Sundar and Choudhury in press).

No case of mortality was observed in juvenile birds. Their habit of crossing the road could result in the death of individuals, as reported by Parasharya *et al.* (1989). However, no data is available on this form of mortality, which seems to be rare. Egg stealing was observed in practically the entire range of distribution. Eggs are taken for food, and medicine (to treat eye ailments and diseases in cattle; also reported by Tatu 1999). Egg stealing could be the most important reason for the observed low recruitment in the species. In certain areas such as Chandrapur in Maharashtra, and Bandhavgarh Tiger Reserve in Madhya Pradesh, removal of eggs from the few breeding pairs can result in total breeding failure for the entire population. This can be a cause for concern in areas like Kota (Rajasthan), where the population is highly localised, and there is a high incidence of egg removal (A. Nair, *pers. comm.*).

From the available data on demographic factors of sarus cranes (Table 3), the percentage of breeding pairs and recruitment observed

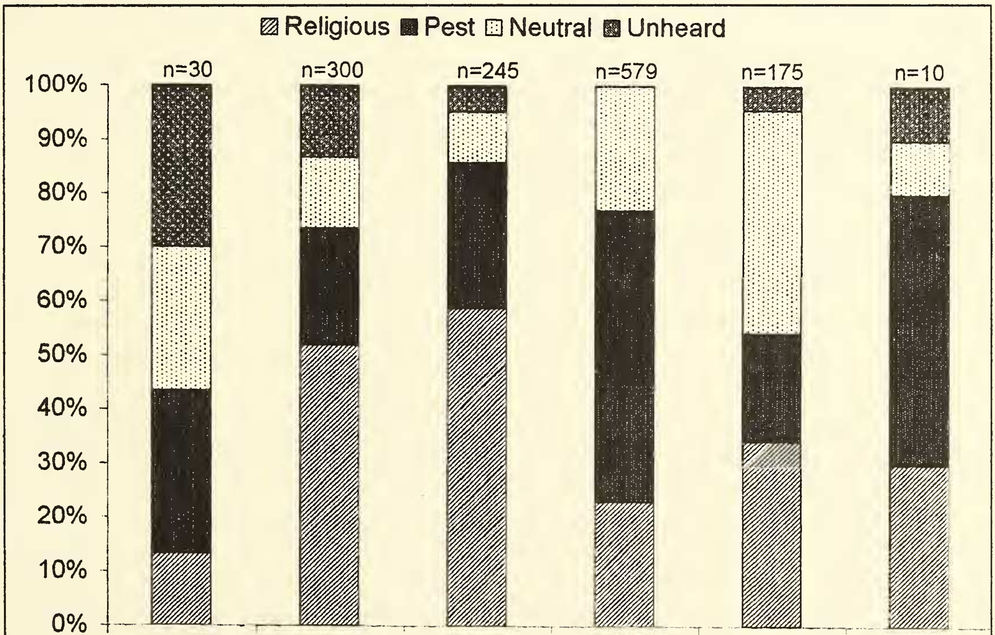


Fig. 9: Opinion of people on sarus cranes in different states*
(* - Only states where at least 10 people were interviewed are included)

during this survey is the lowest. There could be several reasons for this:

1. Breeding incidence has reduced due to decrease of preferred breeding habitat (see Gole 1989, Archibald and Meine 1996).
2. Egg mortality has increased due to stealing by locals.
3. In previous studies, demographic factors were calculated from data for winter surveys, when incidence of breeding is higher.

**Implications for conservation**: Sarus cranes have a low breeding population and seemingly low recruitment. This makes them vulnerable, and local populations can easily be decimated by removal of select wetlands that the birds use for breeding. Regular surveys have to be carried out to keep a check on breeding grounds and to incorporate protection measures in their management. The importance of maintaining natural wetlands, which are undoubtedly superior habitats for sarus crane breeding and foraging, cannot be overemphasized. However, in the context of India, which is primarily an agricultural country, it may be difficult to develop and maintain large tracts of purely natural wetlands. In this light, the utility of a mosaic of small natural wetlands, interspersed within agriculture fields, can be suitable surrogates to natural wetlands. Mechanisation in agriculture practices will be deleterious for populations in agriculture fields. Prevention of egg stealing, minimum disturbance to nesting pairs and families with young, is important to ensure maximum breeding success. The increasing apathy of locals towards the crane may prove deleterious for its survival. Conservation plans should include protocols by which the locals can be educated on the importance of sarus cranes, and should emphasize the importance of local participation in the effort. Of particular and urgent need is baseline data on several aspects of the ecology of sarus cranes. Important among these is detailed information on breeding requirements, habitat use and selection, patterns of local migration, and behavioural ecology of the species.

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